Crew Centered Display Concepts

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- Background info
  - Brief review of pre-HSR work
  - HSR involvement
- Current Work
  - SVS Retrofit assessment and analysis
  - DFW data analysis
  - EGE preparation
- Future Work
  - EGE deployment
  - Continued participation in the SVS program (at least through 2004)

CCDC Background and Recent History

- **Referred to as the Cockpit Technology Branch (CTB) prior to 1993**
  - Advanced pictorial display concepts
  - Flat Panel display media research
  - Pilot/machine interface work
- **Became part of an Industry/NASA/Academia team known as eXternal Vision Systems (XVS) (1993 to 1999)**
  - XVS team supported the Flight Deck element of the High Speed Research (HSR) program
    - Developed and tested the No-Droop Nose Concept cockpit
  - LaRC XVS group
    - Led many simulation and flight test evaluations
    - Established overall requirements for PXD and IFOV displays
    - Developed Surveillance Symbology system
  - Proved the feasibility of the No-Droop Nose Concept

- **XVS Basic Mission**
  - MD-11, B-747 Class operations, airfields, weather
  - No Degradation in Workload
  - Equivalent Safety (Goal: Significantly Improved Safety)
  - Certifiable
  - Pilot and Airline Manager Acceptable
- **Critical Operating Condition is Day VMC**
  - ATC not ultimately responsible for aircraft separation
  - See to Follow and See to Avoid

HSR Flight Test Vehicles

USAF Total In-Flight Simulator

NASA LaRC B-737 TSRV

Early XVS Flight Tests

- **FL1 Explored issues regarding computer generated outside view with camera Primary XVS Display (PXD) views**
  - NASA B-737
  - Visible spectrum and FLIR cameras
  - Computer generated terrain
- **FL2 Established Horizontal Field of View (H-FOV) requirements**
  - TIFS
  - Used window masking
- **FL3 Evaluated conformal display and camera location issues**
  - NASA B-737
- **FL4/TIFS.3 Evaluated Surveillance Symbology and Guidance and Flight Control issues**
  - TIFS
  - Single HDTV PXD
  - First test of Inboard Field of View display

FL5 Flight Test

- *Validated No-Droop Nose Concept cockpit*
  - Full 50 deg V by 40 H FOV PXD
  - In-board Field of View display
  - PXD Eye-limiting resolution
- *TIFS provided actual "look and feel" of flying a High-Speed Civil Transport*
  - 6-DOF model simulated
  - Handling qualities evaluated during approach and landings
- *Performed traffic encounters to test critical VMC operations*
  - Validated Surveillance Symbology system
  - Proved Feasibility of No-Droop Nose Cockpit

SVS-AVL

- **Transitioned to the Synthetic Vision Systems (SVS) element of AvSP during 1999**
  - Became Crew-Centered Display Concepts (CCDC)
- **Utilized HSR-configured TIFS vehicle for SVS kick-off flight research activity**
  - Asheville, N.C.
  - Photo-realistic vs. generic terrain texturing
  - Early look at display size and FOV issues

Current Work

- **Focus on SVS retrofit issues**
  - Head-Down display size and FOV requirements
  - Head-Up opaque HUD concepts
  - Terrain texturing issues
    - Generic vs. Photo-realistic
- **Establish SVS Retrofit concept**

COCKPIT TYPE	RETROFIT APPROACH
Mechanical only	HUD
Existing glass	Existing displays (size-A/B, D)
Future cockpits	New larger displays (size-X)

- **Completed first round of testing**
  - Asheville N.C. simulation and limited flight test
  - DFW simulation and ARIES flight testing

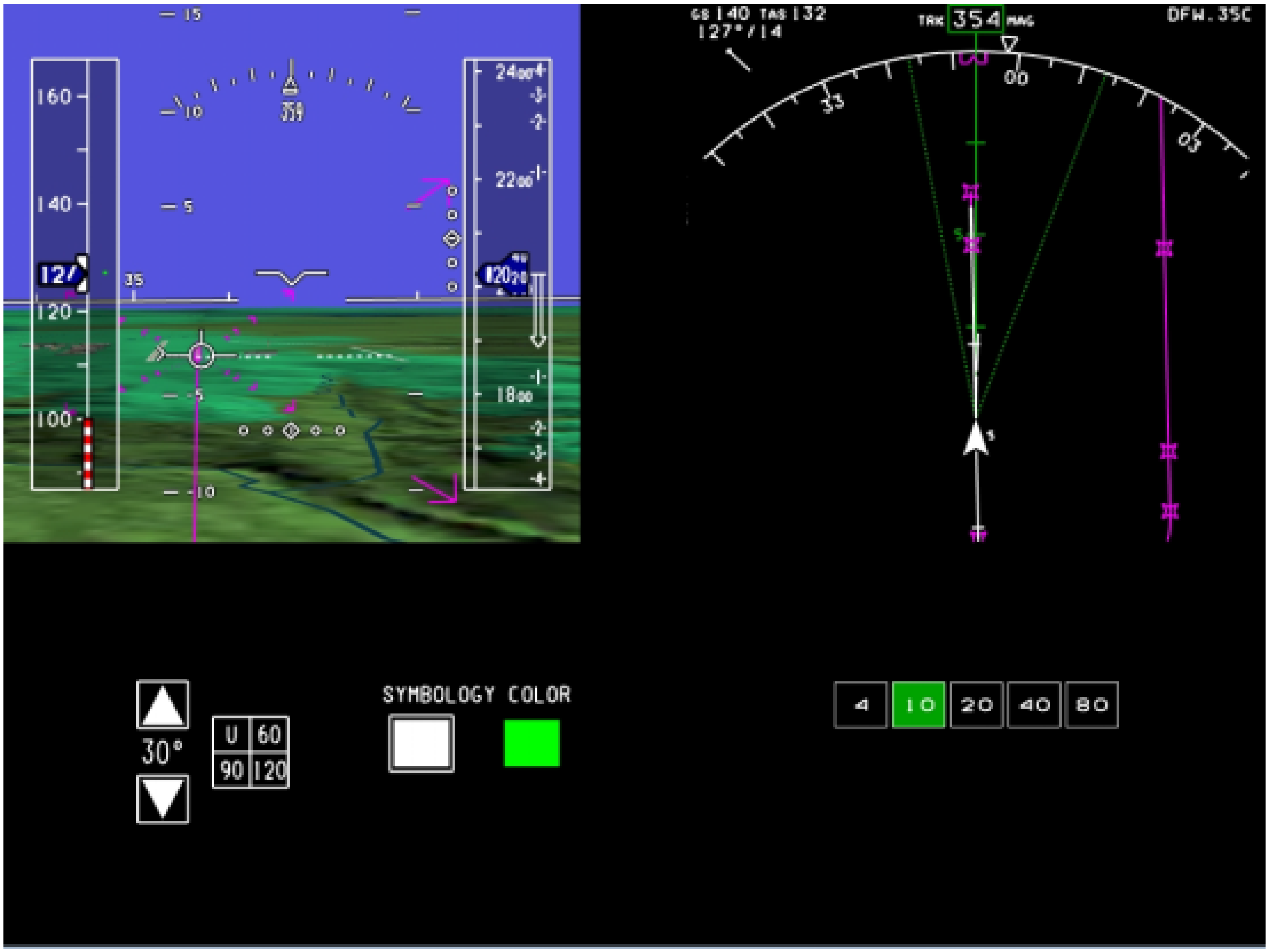
Current Facilities

Experimental Hardware for DFW research

- **SVS Research Display**
  - Large, 18.1” High-Brite LCD display with touchscreen and brightness control
  - Displays A/B, D, X formats
  - Capable of SXGA resolution
  - Designed for easy in-flight removal
- **SVS Graphics Engine**
  - 2 Intergraph Zx1 PCs
    - Dual 800-MHz Processors
    - 1 Gig of RAM
  - Wildcat 4110 Video board
    - 256 MB of Texture memory
  - For R/C work: included Obsidian-2
  - Provided capability to generate photo-realistic terrain – on HUD and HDD
  - **Less than $10,000 per PC!**

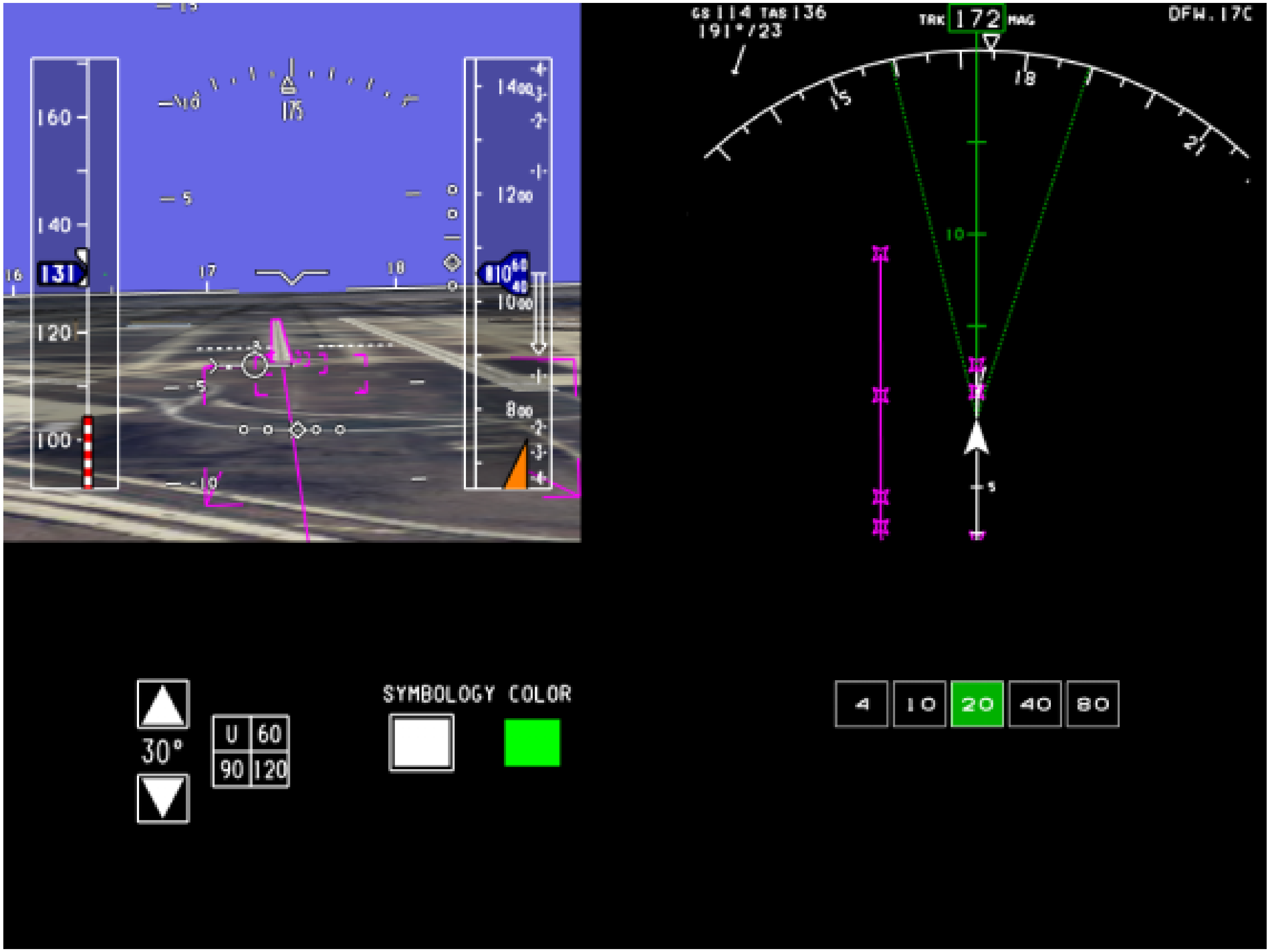
SVDC-DFW Flight Test

Size-D, 30 deg FOV, Generic-texture



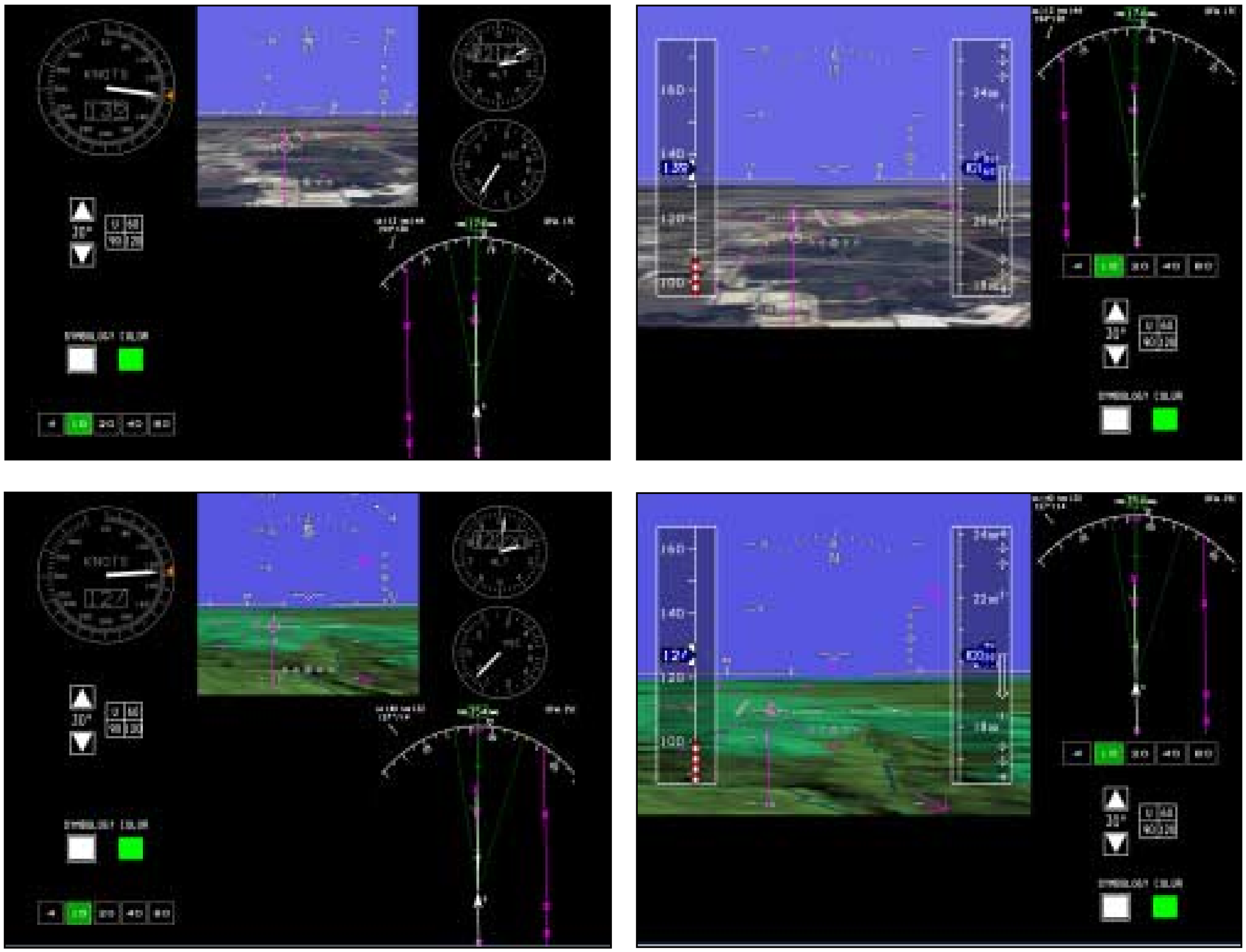
SVDC-DFW Flight Test

Size-D, 30 deg FOV, Photo-texture



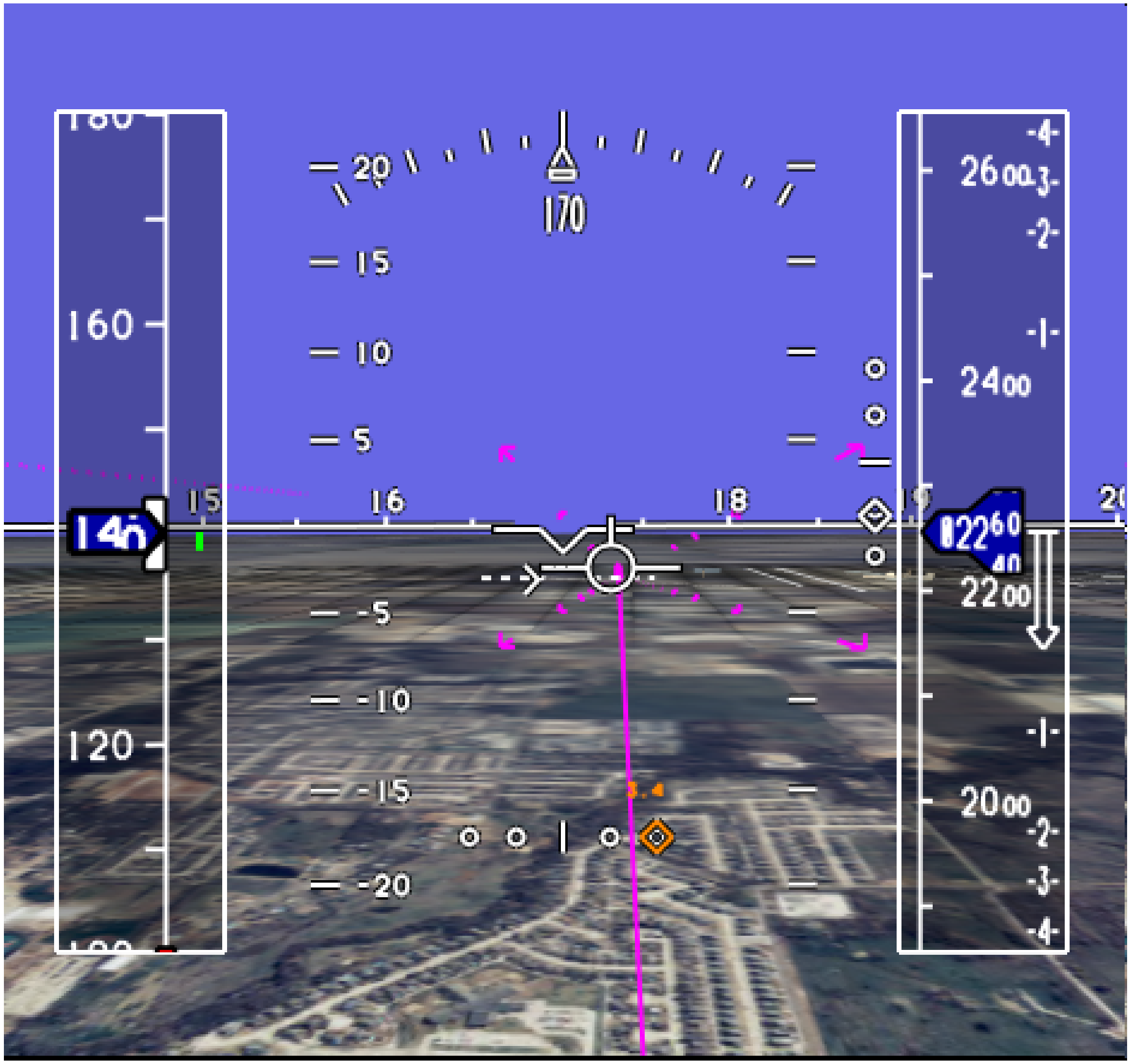
Size A/B and Size-X Concepts

Size A/B



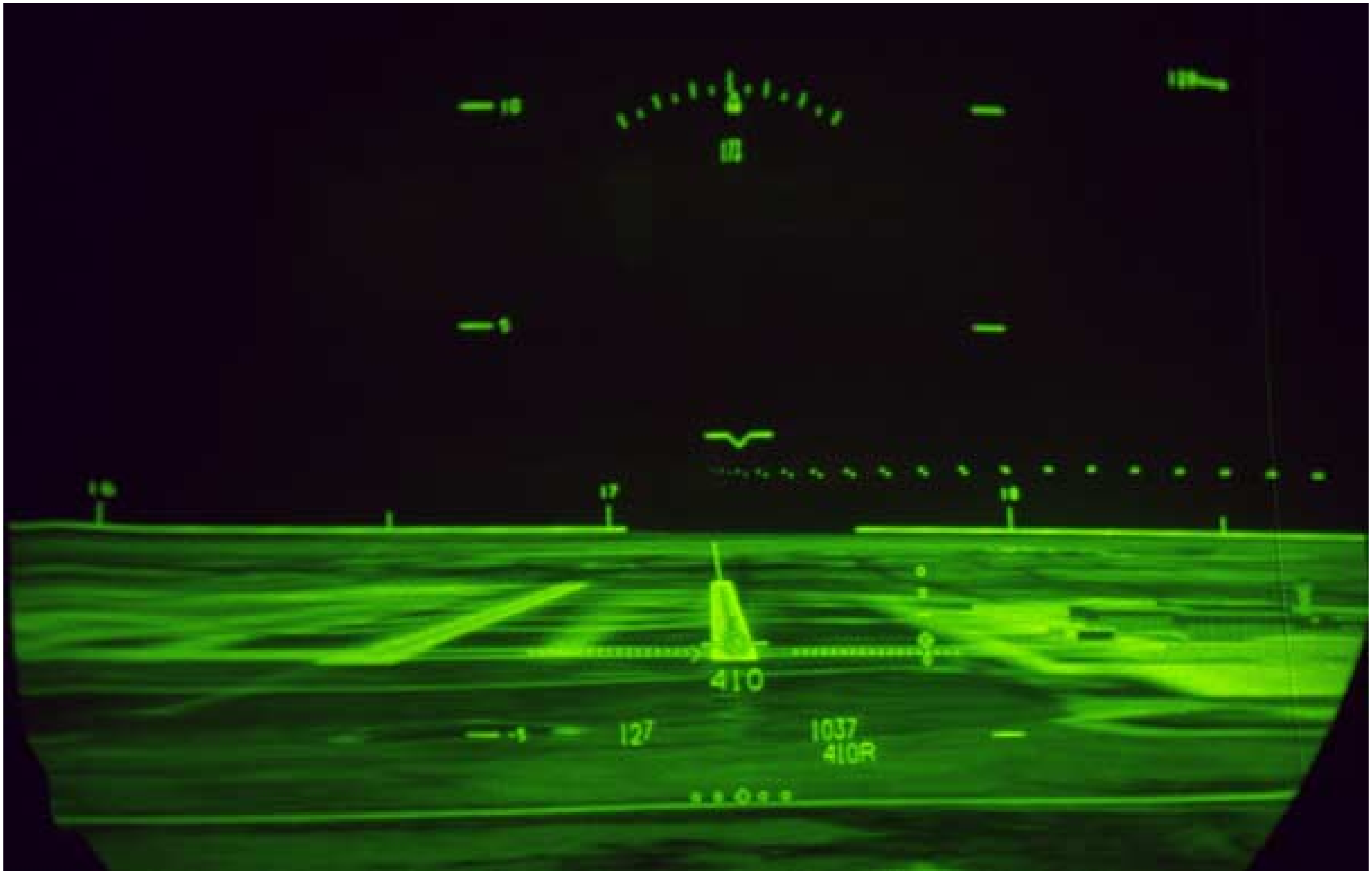
Size X

Photo-X Movie

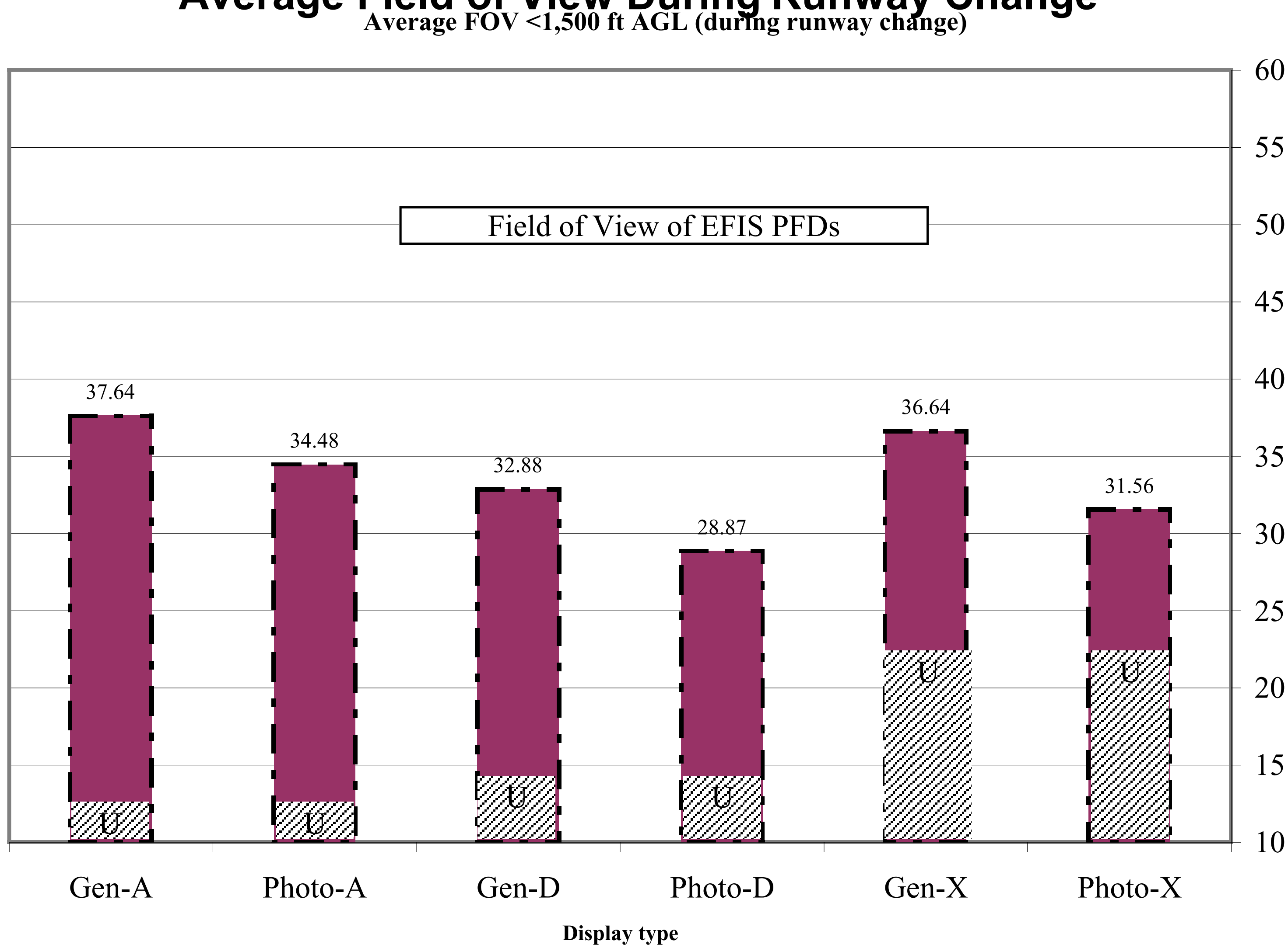


SVDC-DFW Flight Test

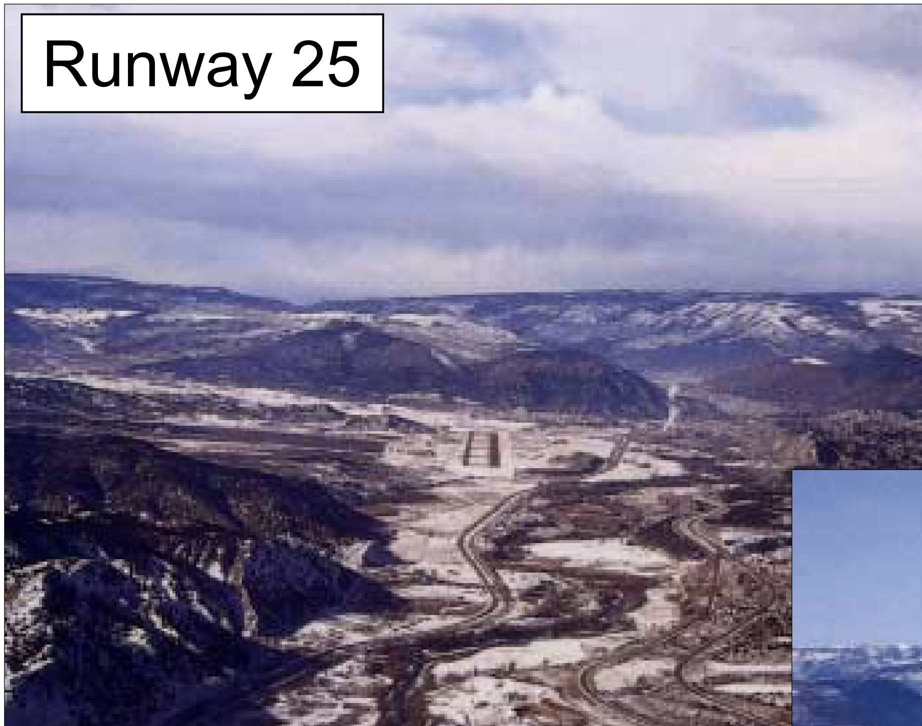
Photo-textured HUD



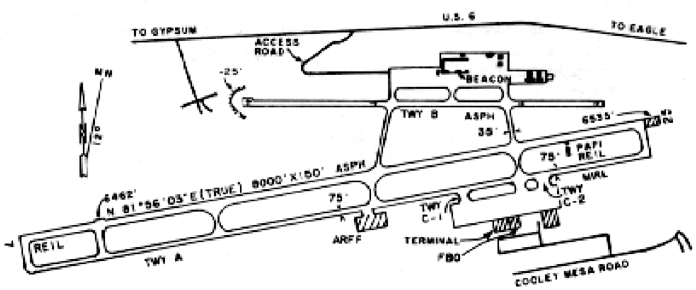
Average Field of View During Runway Change



Next: Eagle/Vail



Runway 25



<u>The other terrain extreme from DFW:</u>

– Terrain-sensitive area
– Compare with DFW results
– Investigate SVS concepts to improve terrain awareness during RNP approaches and reduce Min Descent Alt. (MDA)
– Include Terrain Awareness and Warning System (a version of EGPWS) in evaluations

Runway 7

Future CCDC Research Issues

Crew Systems Peer Review - Synthetic Vision

- Effective Synthetic Vision Presentation on Tactical Displays (PFD and HUD)
- SV information on Strategic Display (Navigation Display)
- Pictorial Scene Information
- Limited Visibility (down to Category III) SVS Operations at Type I runways (both departure and arrival operations)
- Integration of Surface Operations Display Concepts with Airborne Display Concepts
- Situation awareness (SA) issues
- Integration of SVS with TAWS
- SVS Integration with Enhanced Vision Sensors
- Human factors design issues for Flight Data information integration with SV scene
- Failure of information (Backup instrumentation/Reversionary modes)
- Utilization of Advanced Display Media
- Format of Traffic and Weather Portrayal on Tactical and Strategic Displays